The New Jupiter Revealed by Juno

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Juno Mission Overview

- **Principal Investigator:** Scott Bolton, Southwest Research Institute

- First outer-planet solar powered mission
- Spinning, polar orbiter launched on August 2011
  - 5-year cruise to Jupiter, arrived July 4, 2016
  - 53-day polar orbit
- Suite of eight science instruments to investigate Jupiter's
  - Interior
  - Atmosphere
  - Magnetosphere

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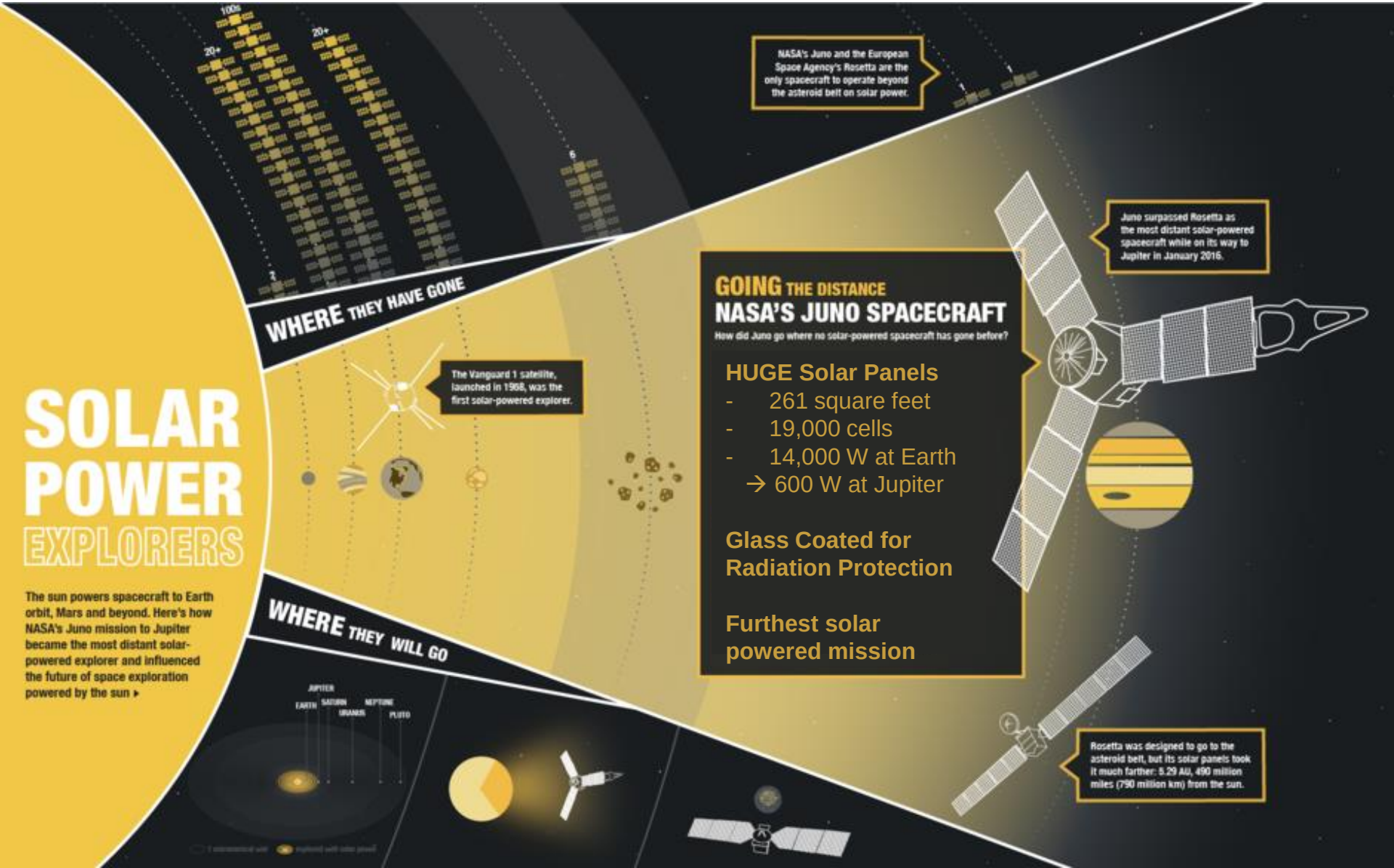
Engineering Challenges: Solar Power



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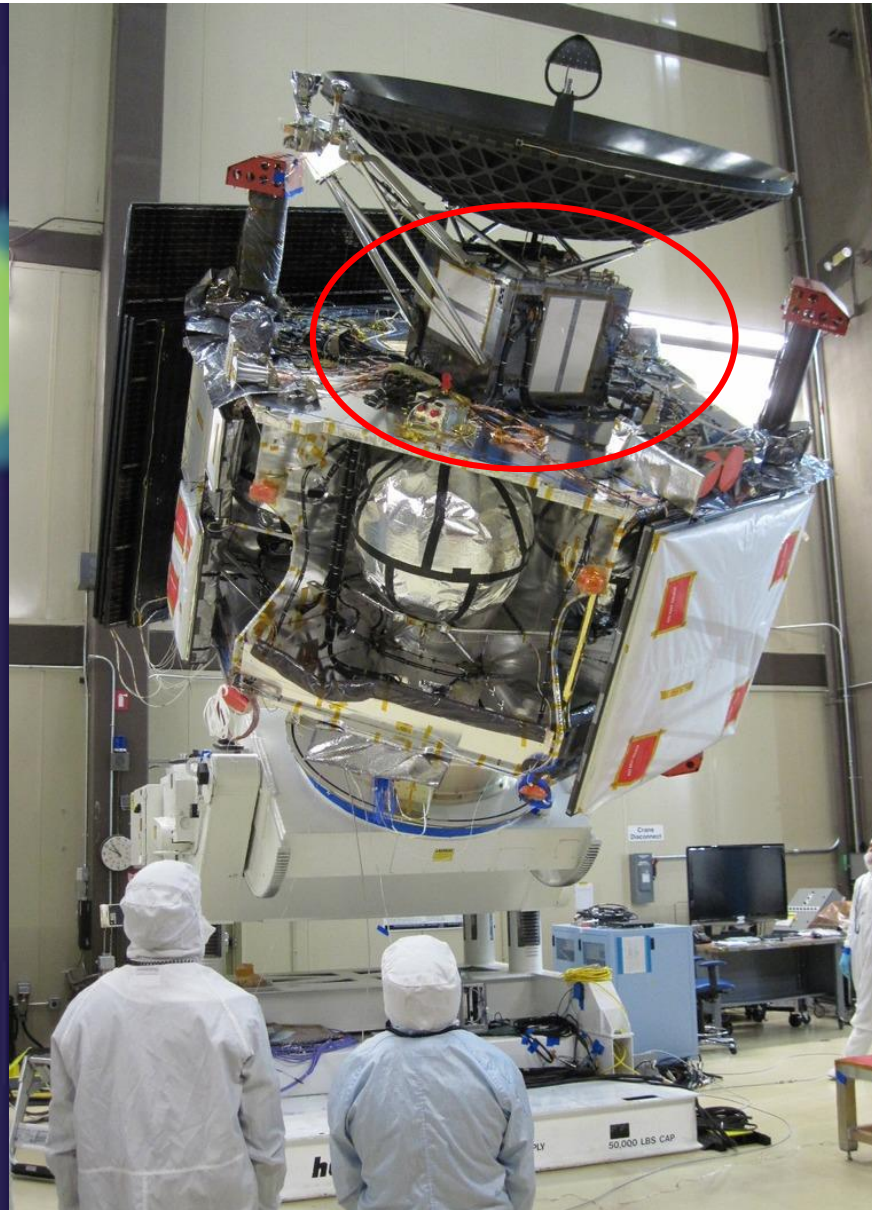
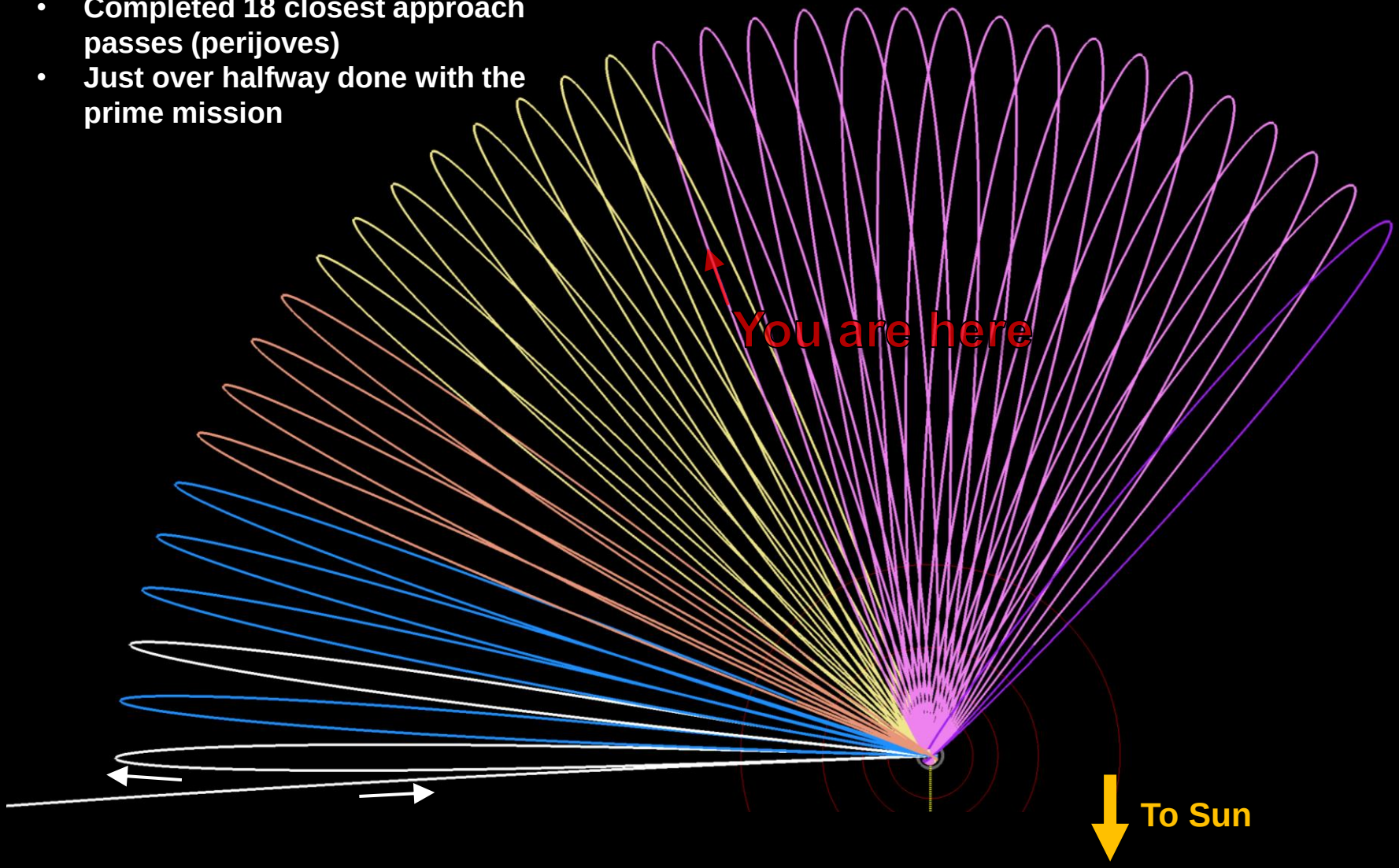
Engineering Challenges: Radiation



Where is Juno Now?

- **Completed 18 closest approach passes (perijoves)**
- **Just over halfway done with the prime mission**



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Malin Space Science Systems

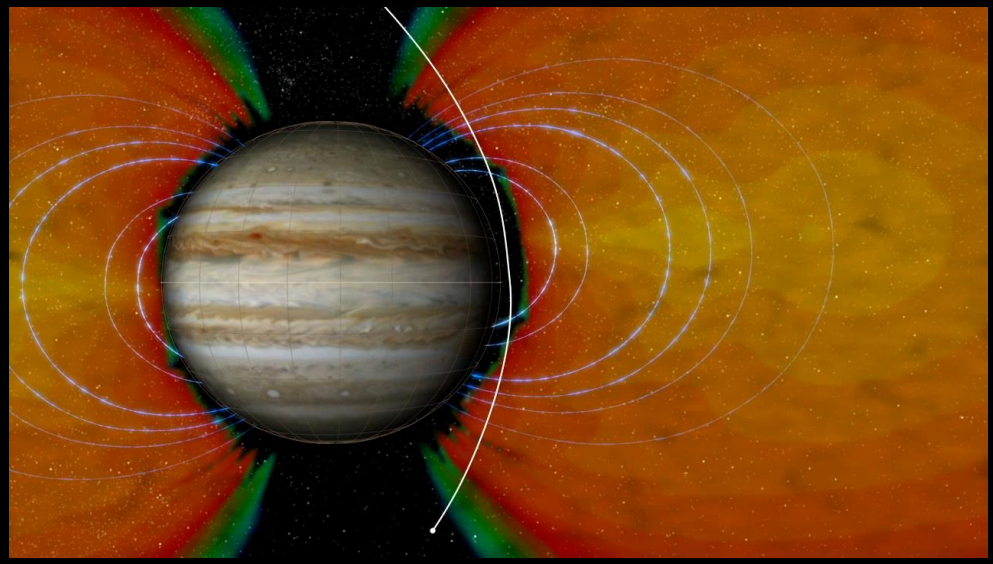
Juno's Science Objectives

Origin
Determine the abundance of water and constrain the mass of Jupiter's dense core to distinguish among theories of planet formation.

Interior
Understand Jupiter's interior structure and how material moves deep within the planet by mapping its gravitational and magnetic fields

Atmosphere
Map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes

Magnetosphere
Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

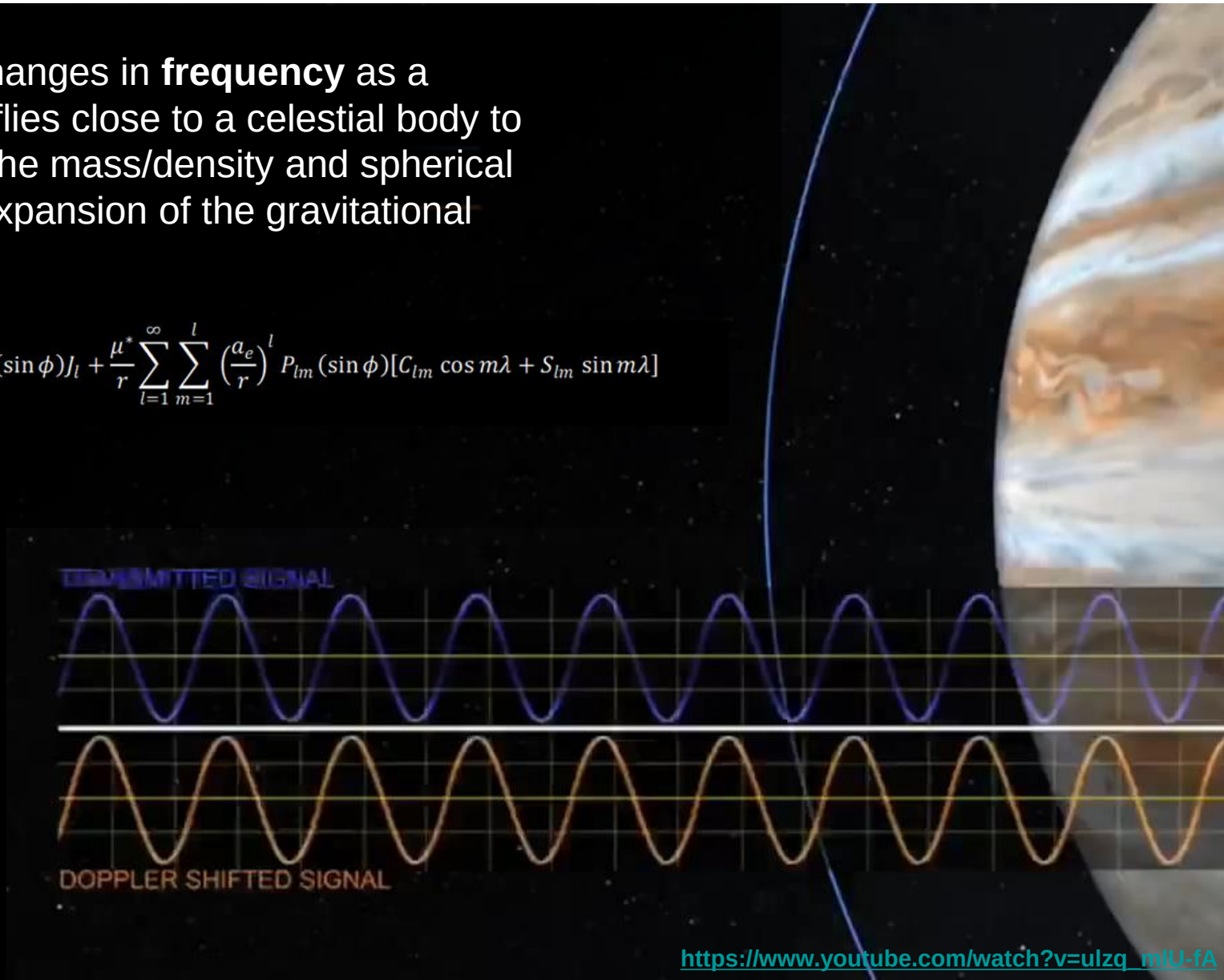


*** Gravity Science (JPL, ASI)
** * Magnetometer— MAG (GSFC)
**** Microwave Radiometer— MWR (JPL)
* Jupiter Energetic Particle Detector— JEDI (APL)
* Jovian Auroral Distributions Exp.— JADE (SwRI)
* Plasma Waves Instrument— Waves (U of Iowa)
* UV Spectrograph— UVS (SwRI)
** Infrared Camera— JIRAM (ASI)
* Visible Camera— JunoCam (Malin)

Gravity Science Overview

- Examine changes in **frequency** as a spacecraft flies close to a celestial body to determine the mass/density and spherical harmonic expansion of the gravitational field

$$U = \frac{\mu}{r} - \frac{\mu^*}{r}\sum_{l=1}^{\infty}\left(\frac{a_e}{r}\right)^l P_l(\sin\phi)J_l + \frac{\mu^*}{r}\sum_{l=1}^{\infty}\sum_{m=1}^{l}\left(\frac{a_e}{r}\right)^l P_{lm}(\sin\phi)[C_{lm}\cos m\lambda + S_{lm}\sin m\lambda]$$



https://www.youtube.com/watch?v=ulzq_mIU-fA

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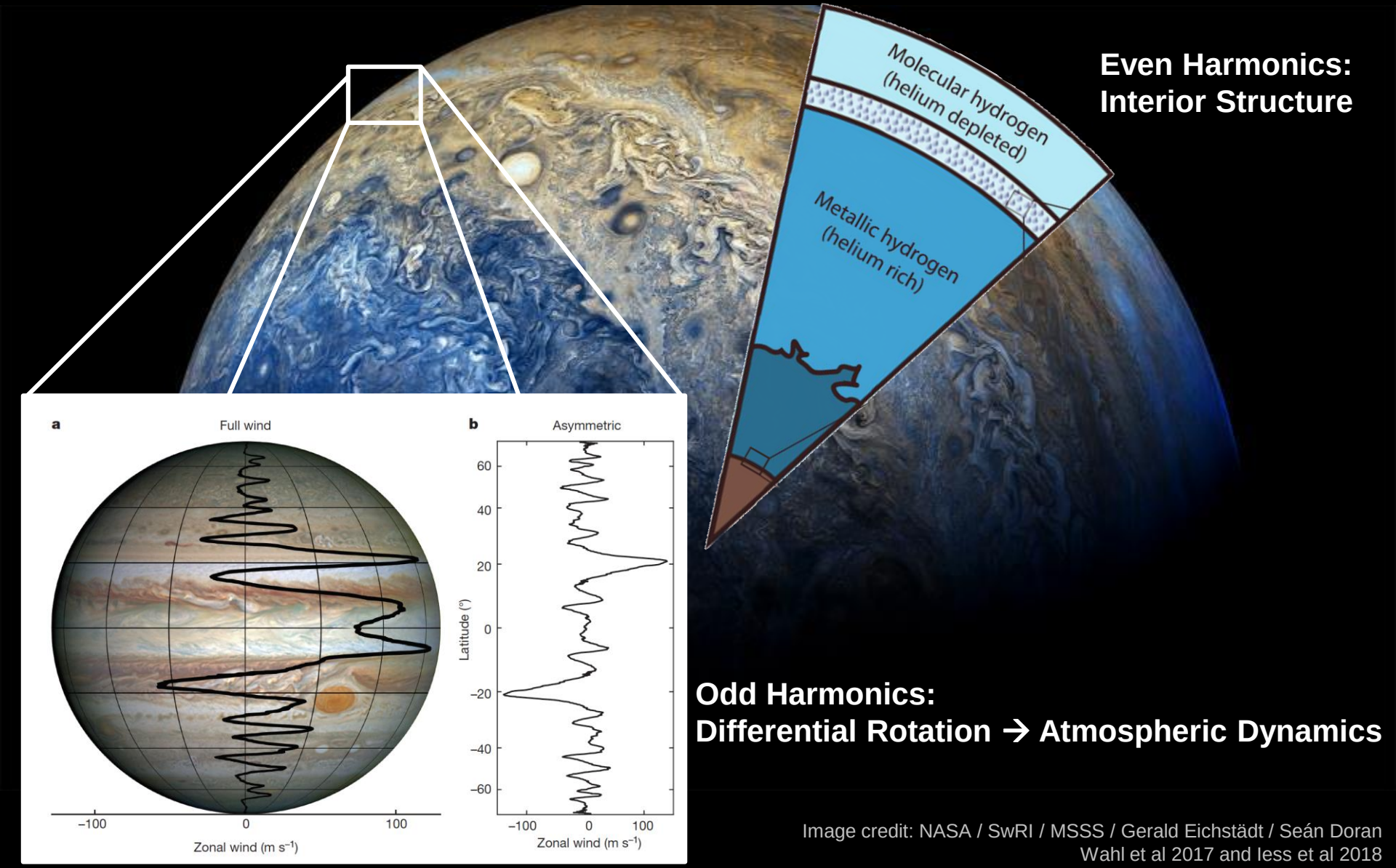
Jupiter's Interior



Even Harmonics: Interior Structure

Odd Harmonics: Differential Rotation → Atmospheric Dynamics

Image credit: NASA / SwRI / MSSS / Gerald Eichstädt / Seán Doran
Wahl et al 2017 and Iess et al 2018

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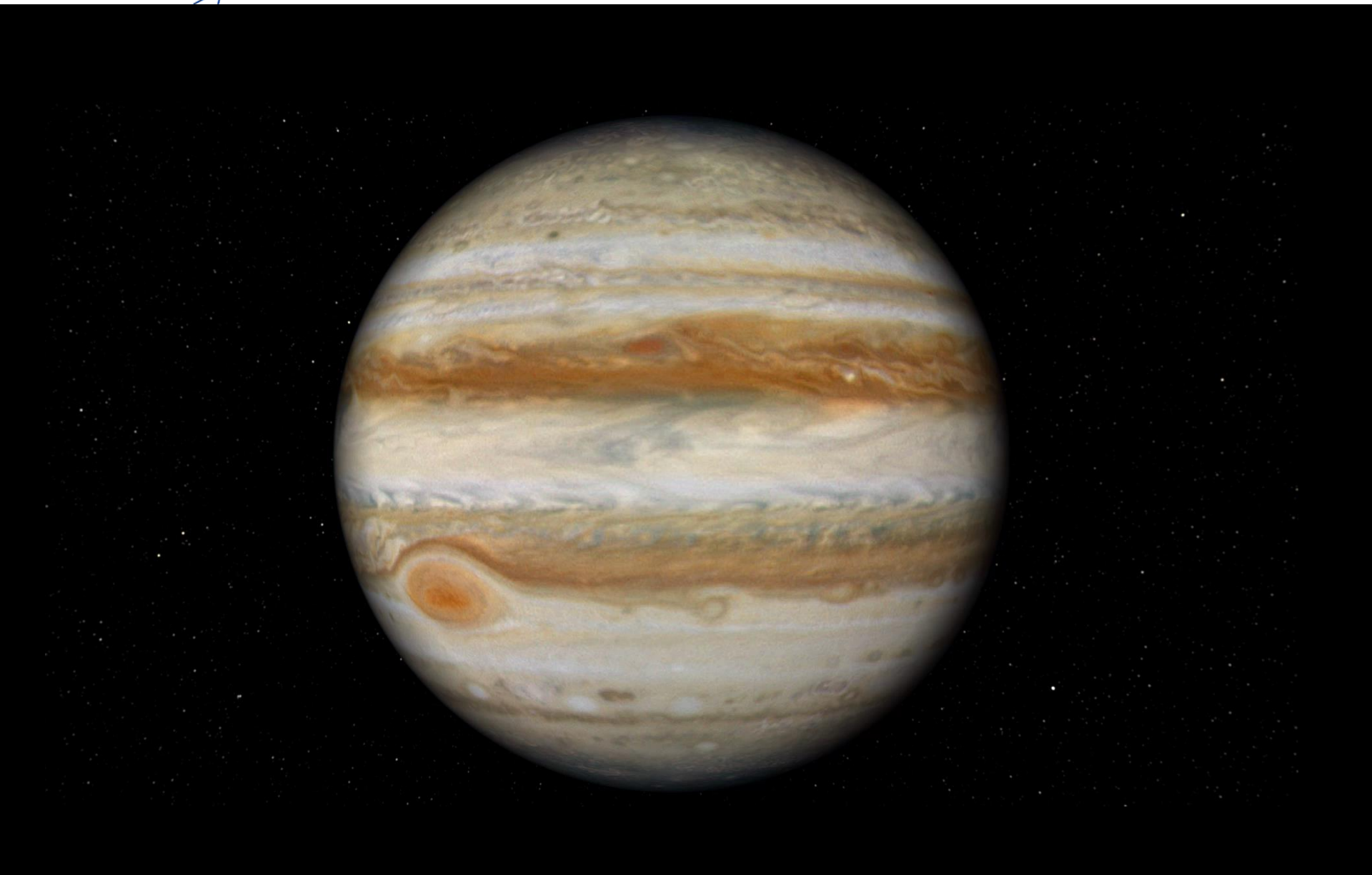
Probing the Depth of the Atmosphere



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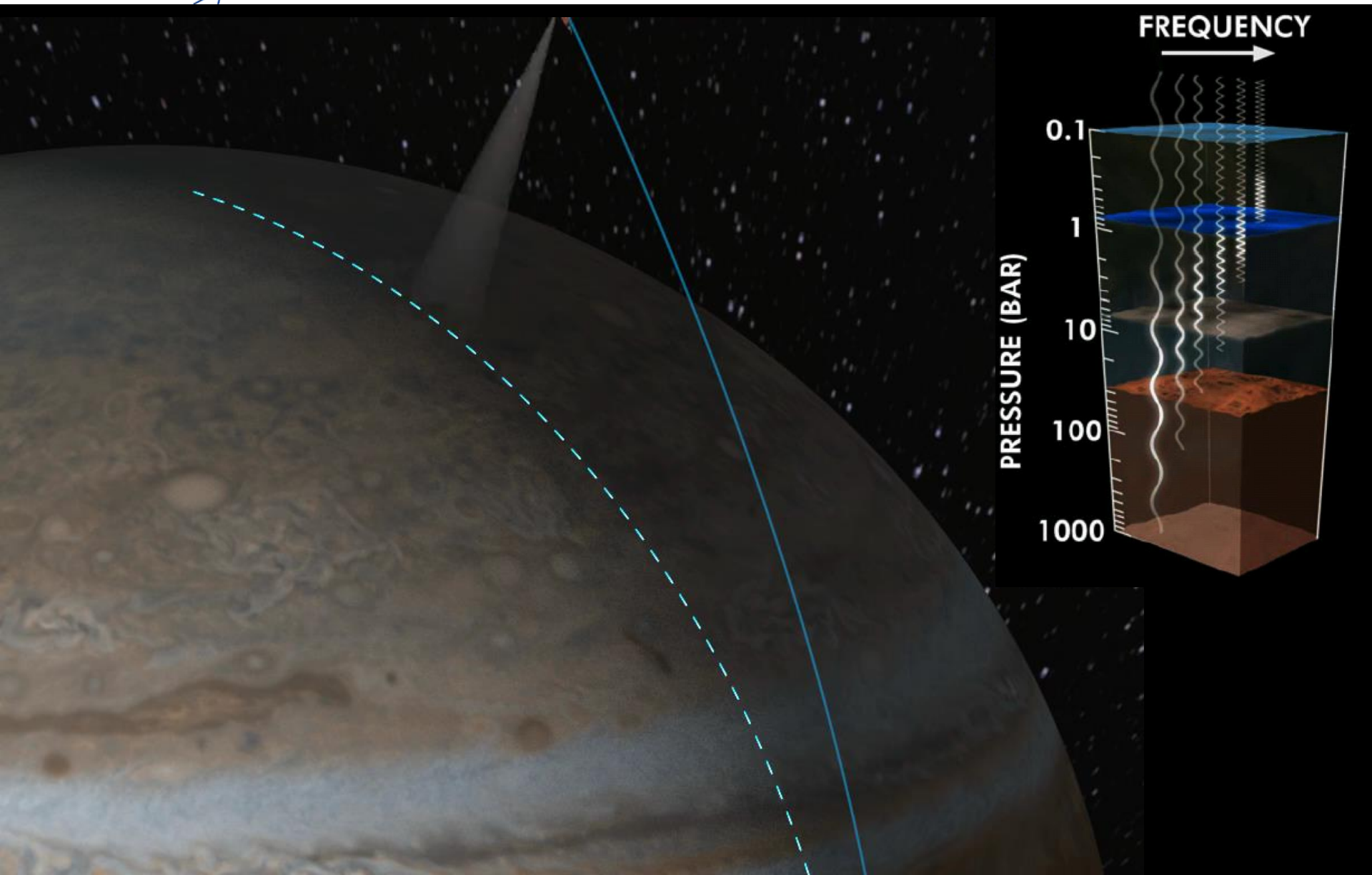
MWR Sees Beneath the Clouds



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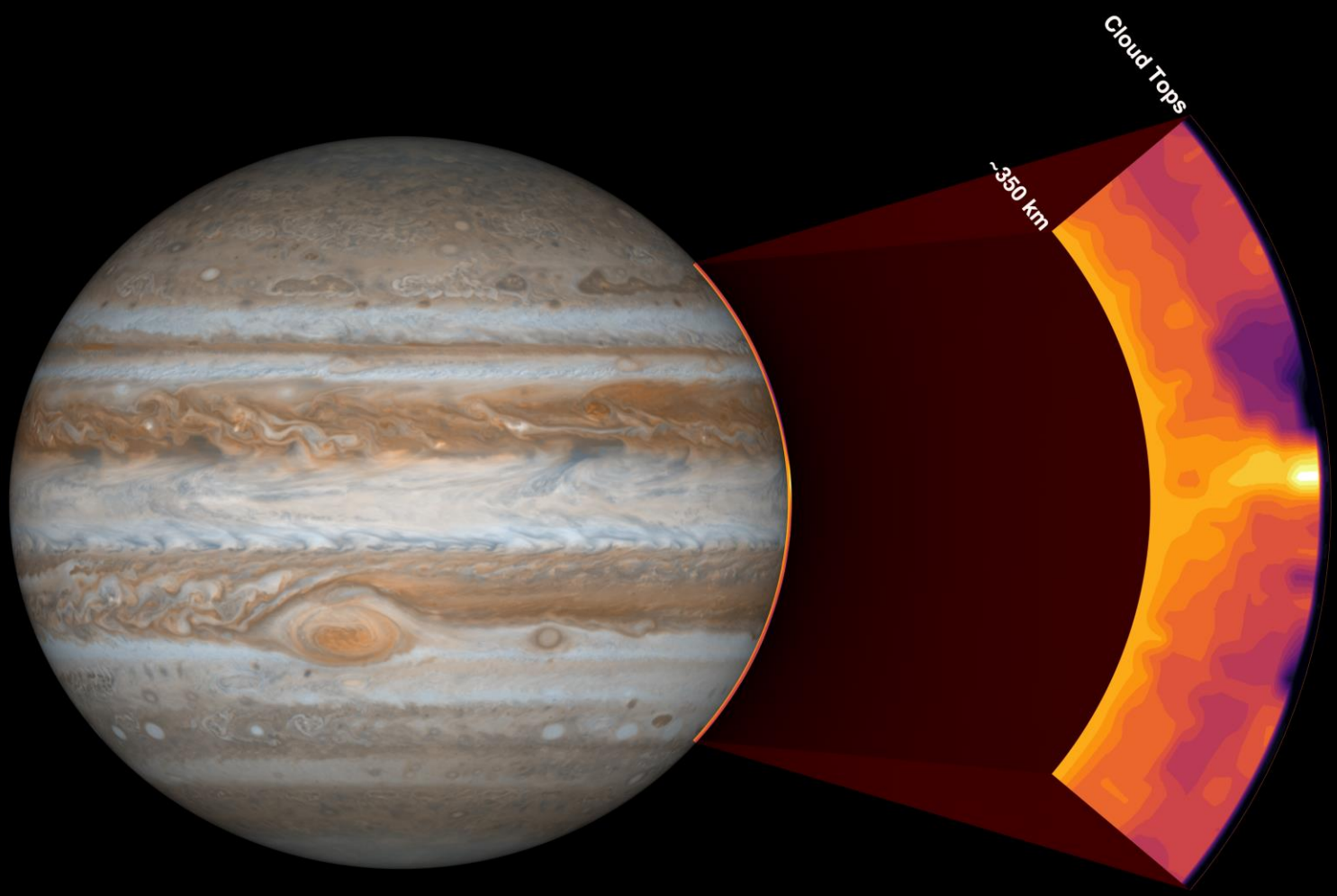
The Atmosphere is Surprisingly Complex



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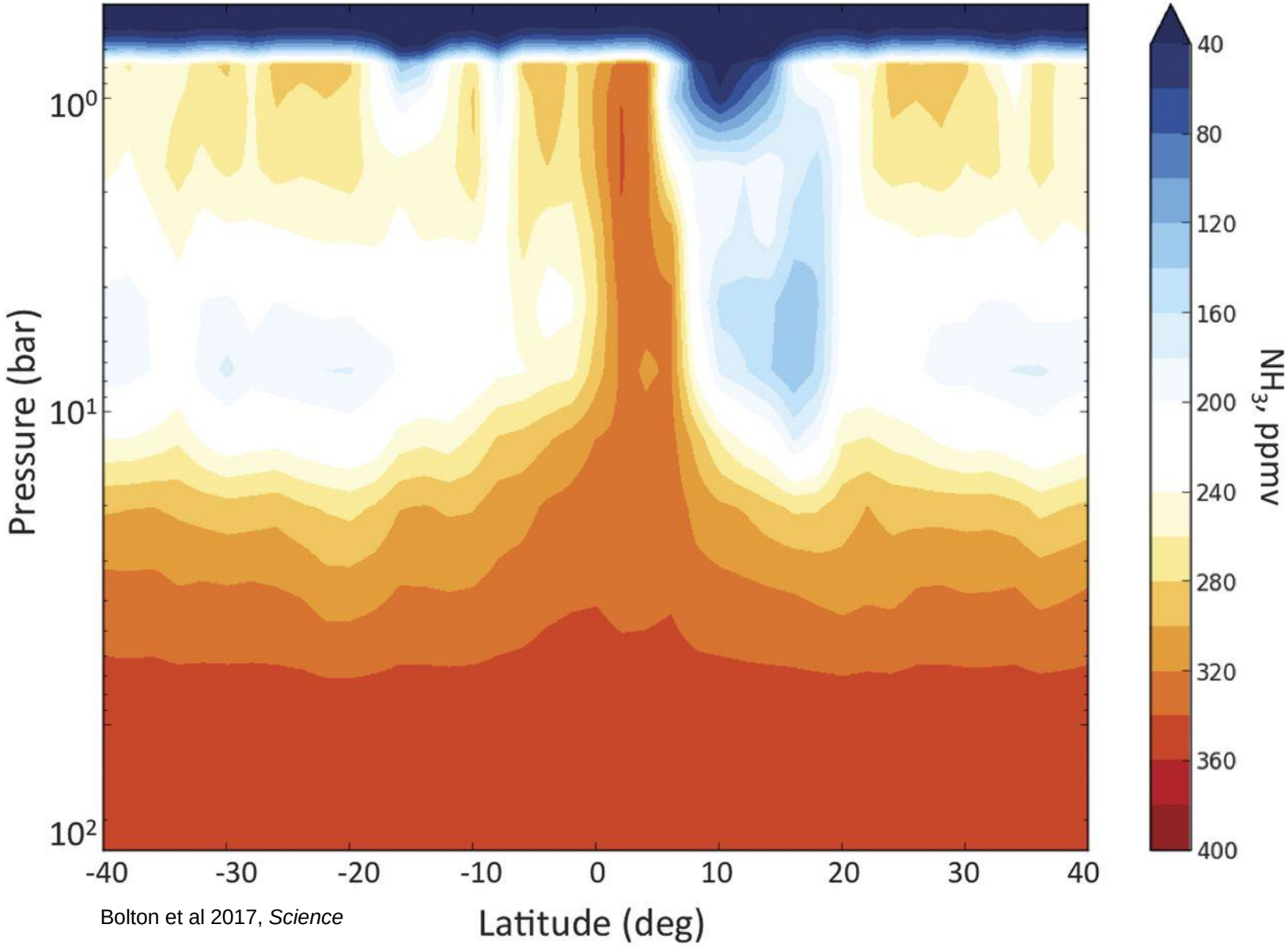
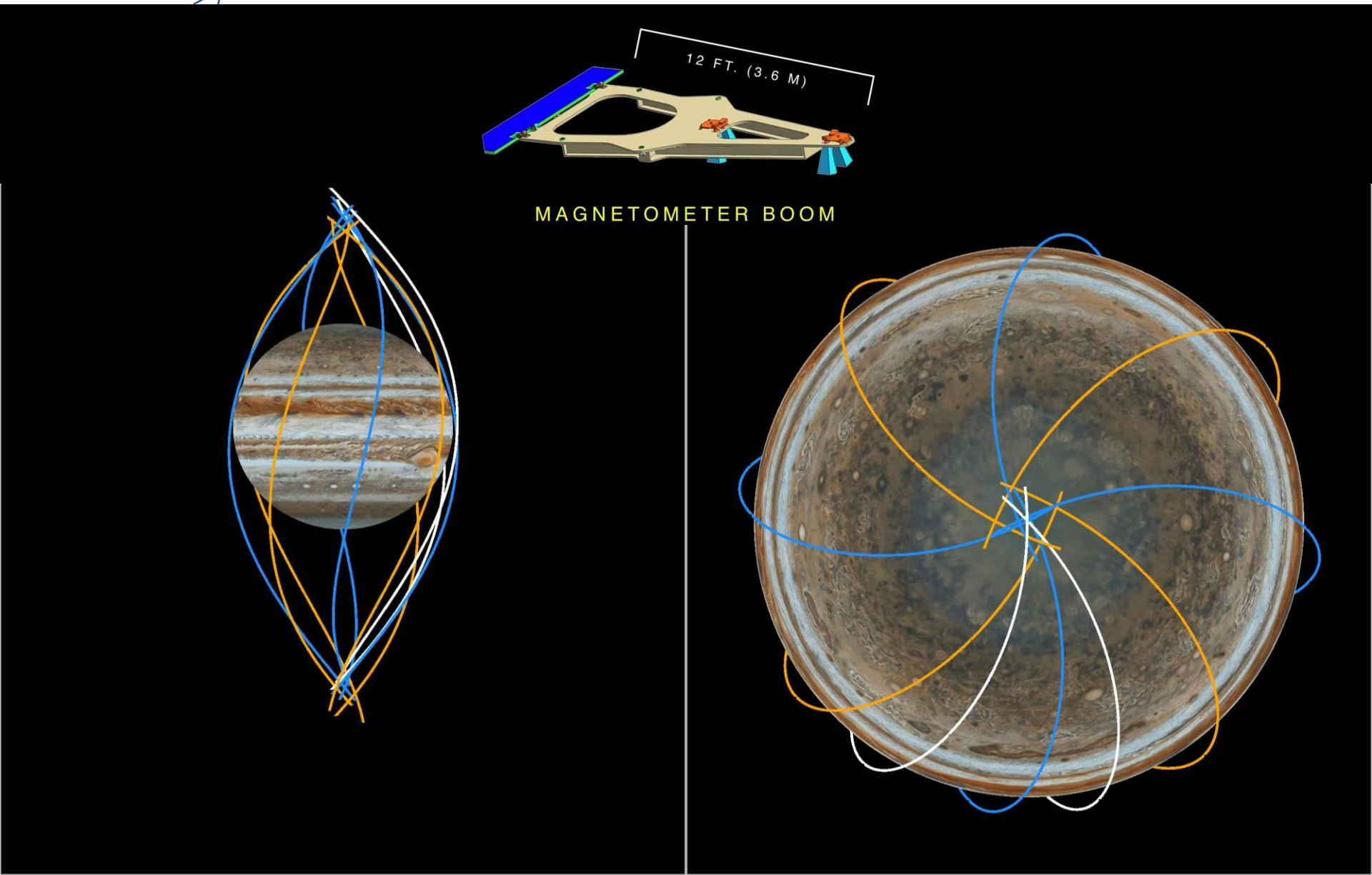
Ammonia Distribution



Bolton et al 2017, *Science*

Project

Mapping the Magnetic Field



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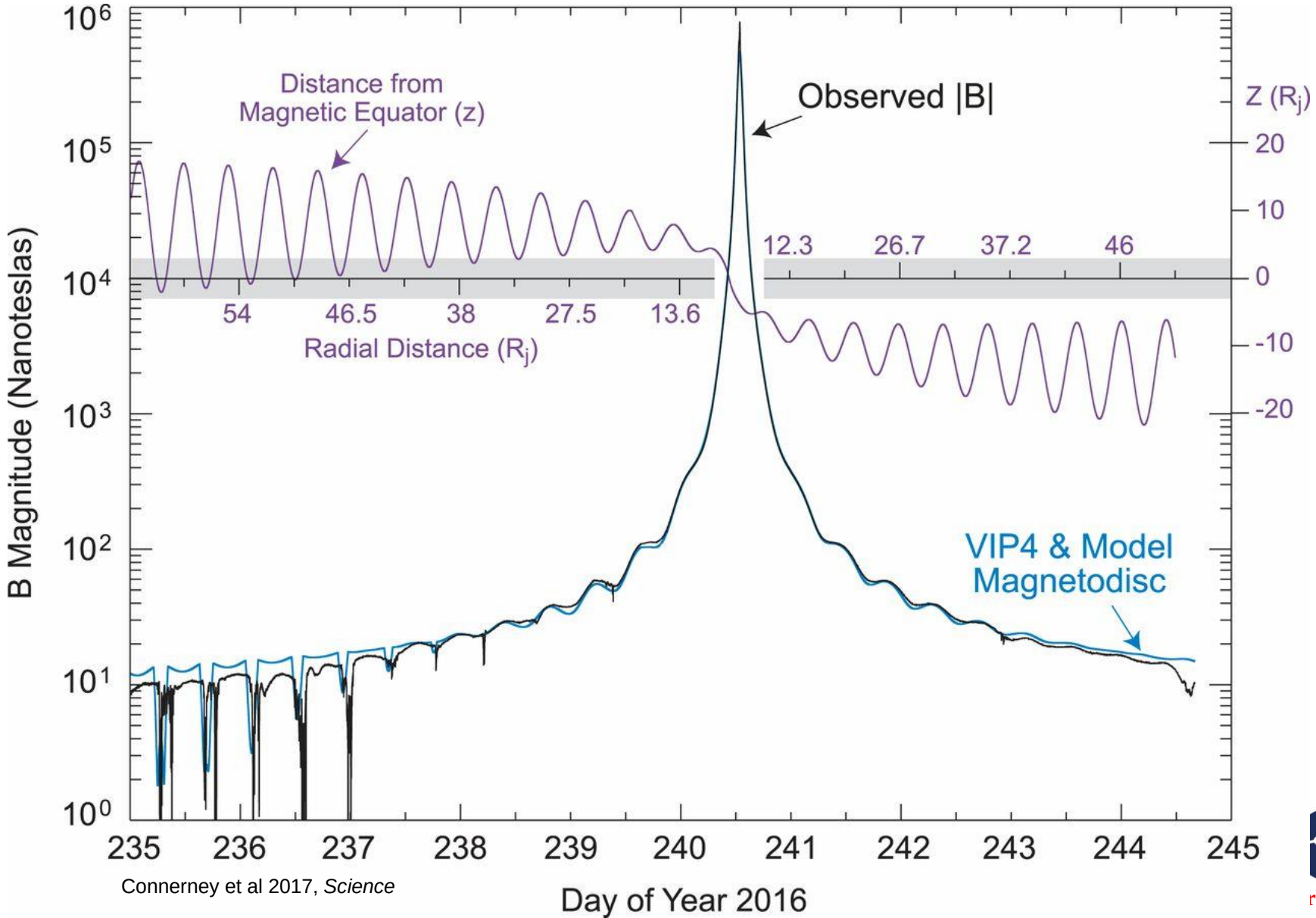
PJ-01 Magnetic Field Mapping



Connerney et al 2017, *Science*

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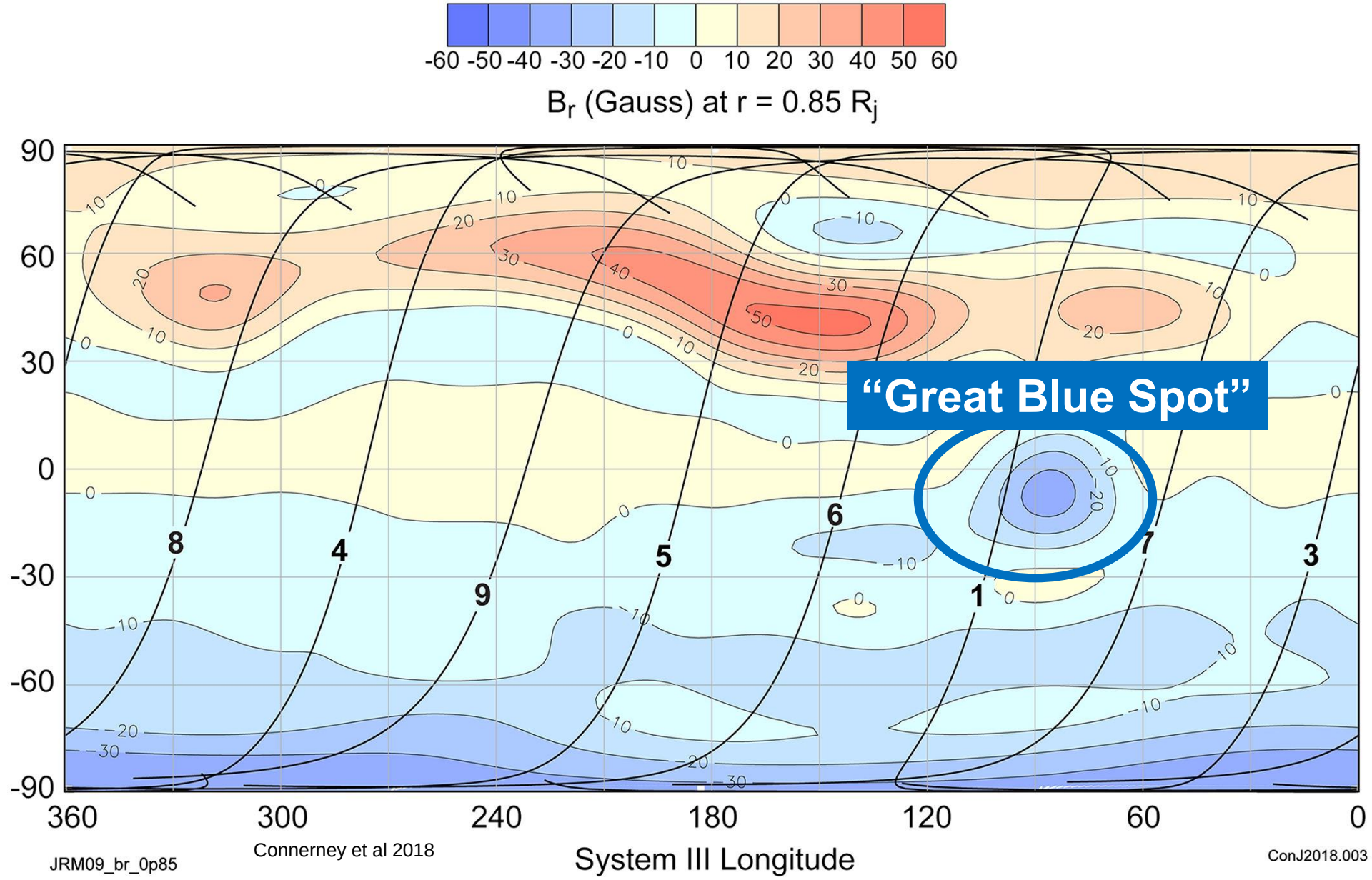
After 8 Orbits: A New Magnetic Map



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Connerney et al 2018

ConJ2018.003

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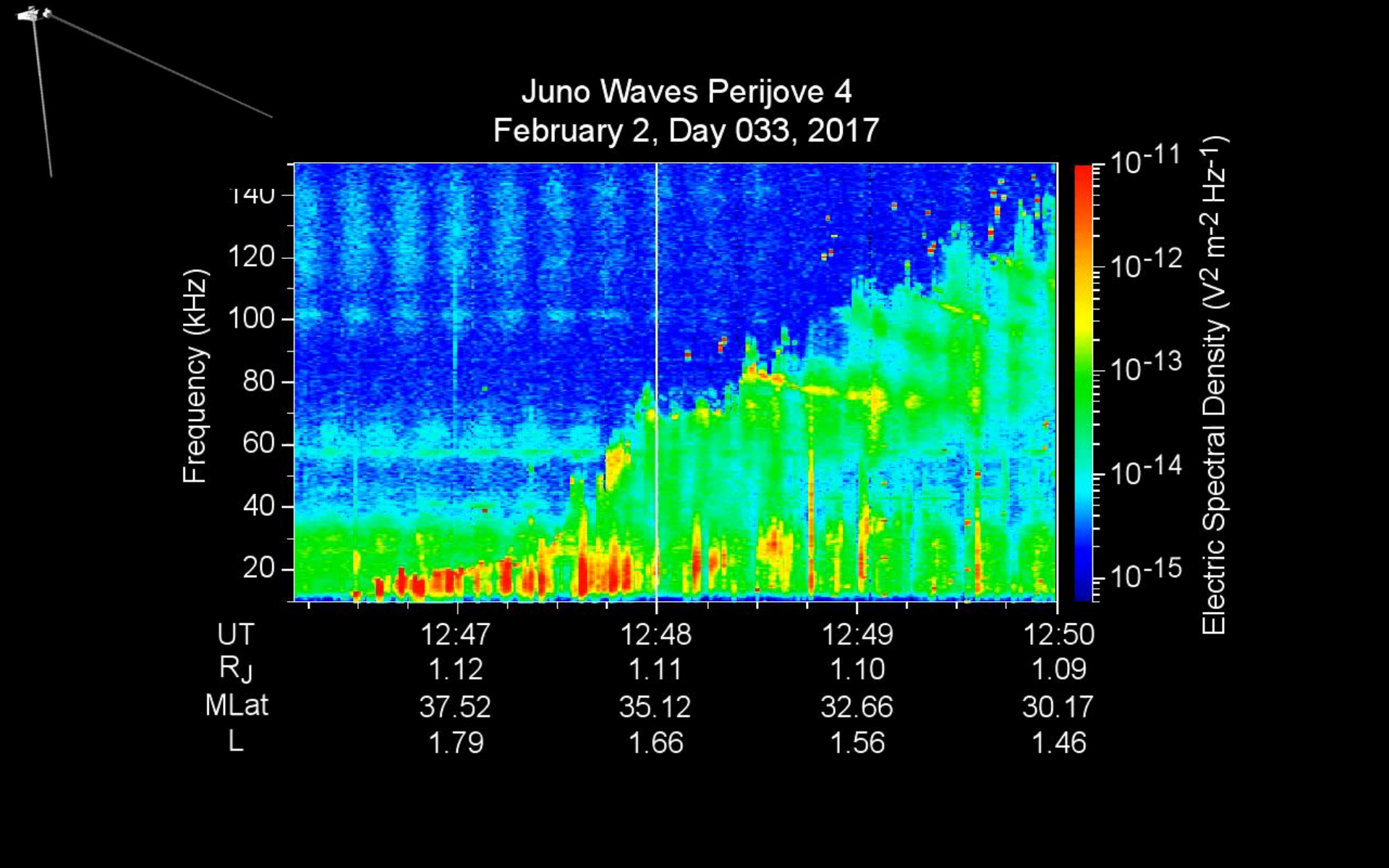
“Sounds of Jupiter” with Waves Instrument



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